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The Archaeological Map of Egypt

(Archaeological Heritage Resource Management System)

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Abstract: In this paper we will present how we employed the latest information technology to produce a powerful documentation and management tool for the Egyptian archaeological sites that are spread all over the country. We will show how we divided the information of the archaeological sites into three levels and how we implemented each of these levels, and how we used the GIS technology to add another dimension of information which is the geographical location. Also we will introduce how we used the multimedia technology in conjunction with the GIS system to document the monument details. This paper will also discuss the different types of information that are gathered and stored in our system, the user information of the system and the system outputs. The different software packages we used in the implementation are also discussed.

Introduction

Egypt, the birthplace of civilization, is pouring out a tremendous wealth of cultural artifacts, which are of world importance. It is estimated that one third of monuments and sites representing the world cultural heritage is found in Egypt. For mankind Egyptian civilization contributed in a very important manner to the making of our history and beliefs. To the Egyptians it represents a national pride and roots, it also represents a great source of revenue to the country and generates employment to a large part of the Egyptian working population. From a scientific prospective it is a source of continuous international interest. However the management and preservation of this heritage has become a serious matter. Paramount are archaeological sites considering their large number and wide distribution around the country. The wide acceleration of urbanization around the archaeological sites as well as environmental issues add another dimension to the problem. In addition to the above problems, there is currently no unified accurate documentation system for these sites.

Due to all these factors there is a demand to register this wealth and ensure its documentation, protection and preservation for future generations. This is best achieved by the creation of a geographical archaeological information system as an essential part of the cultural heritage resource management, and hence the birth of this project **the archaeological map of Egypt**.

The project is a joint effort between the National Center for Documentation of Cultural and Natural Heritage (CULTNAT), and the Supreme Council of Antiquities (SCA). The purpose of this project is to document all the archaeological sites of Egypt and their distribution all over the country, in addition to the documentation of all the monuments within each of these archaeological sites. The project also aims to gather all the world wide scattered information that is related to each Egyptian

archaeological site and make it all accessible through a single easy to use information system, using the most up to date technology.

The Concept

The system is based on providing information at three levels: the national level, the site level and the monument level. Each of these levels is implemented using various technologies. The first level is basically implemented using Geographic Information System (GIS) technology in addition to some multimedia components. The second level is implemented using only GIS, while the third level is implemented using multimedia and virtual reality technologies.

The First Level: The National Level

The main aim of the national level is to build an inventory as well as to document and visualize the geographical distribution of the Egyptian archaeological sites. This visualization gives another dimension of information that can not be obtained from a regular information system. At this level of information, a digitized map of the entire country is displayed. Using the GIS and a vector map, the user is able to arbitrarily zoom into or out of any selected region on the map. He can also perform some geographical measurements like measuring the distance between two land marks on the map. Each archaeological site, which is the main entity at this level, is marked by a single point on the map. In addition to searching for sites from the map, the user may decide to search for sites by their names (could be Egyptian, or Greek, or Coptic name), by period, by type, by governorate, by archaeological region, or a combination of some of the above criteria. The system is bilingual. The user at any time can switch the interface and the data language from English to Arabic and

vice versa. Fig. 1 shows the main screen of the system. Once a site is selected, it is marked on the map and the user can browse through different types of data that relate to that site (see fig. 2).

These data are as follows:

- Basic site information
- Recent photos of the site
- Old photos of the site
- Mission reports about that site
- Bibliography of the site
- Objects in the Egyptian Museum
- Objects in other museums
- Boundary map of the site
- Site details

The site's basic information includes the following attributes:

Site names:

This includes four fields indicating current name, ancient Egyptian name, Coptic name, and Greek name of the site. The current name is the only mandatory field in this group.

Site dominant dating:

This determines the main historical period to which the site belongs. This is a multivalue field as the site may have monuments that belong to different time periods. Each value in the site dating contains three attributes which are the pharaonic period, the dynasty and the king's name. Each dating value can contain either the three attributes or the period and dynasty attributes or just the period. For example a site can have some monuments that belong to King Ramesses II in the 19th Dynasty in the new kingdom, at the same time it can have some other monuments that date back to the old kingdom whereby the dynasty and the king are unknown.

Other periods:

In many cases the majority of the monuments at a site date back to a certain date, and a few are dated to other time periods, these non dominant periods are mentioned in this field. This field is also a multivalue field. In this case only the period is mentioned without dynasty or king.

Site type:

This determines the type of monuments at the site. This is also a multivalue data as the site can contain many different types of monuments. For example a site can have pyramids in addition to tombs and temples. The site type data is divided to two categories. A main category and sub-category. The main category has only four values which are Necropolises, Settlement, Place of Worship, and Others. Each of this categories has many values in the sub category. A site type can be determined either by a main category value or by main category and sub category value depending on the amount of information available.

Description:

This is a memo field that contains a brief description of the site. This field also contains any other information about the site that is not mentioned in any of the above fields.

PM and LÄ:

These two fields stand for:

B. Porter and R. L. B. Moss, assisted by E. W. Burney, now edited by J. Malek, *Topographical Bibliography of Ancient Egyptian Hieroglyphic Texts, Statues, Reliefs and Paintings*. Vol I-VIII; Oxford, reprinted 1994-1999

Lexikon der Ägyptologie, ed. W. Helck, W. Westendorf; Vol. I-VII, Wiesbaden 1972-1992

Which are the most famous Egyptology encyclopedias. These two fields contain the reference of the site in the two above mentioned encyclopedias.

If the user chooses to view recent photos of the site, a set of up to date photos of the sites are displayed.

In the old photos option a set of site photos from the beginning of the 20th century is displayed. This feature together with the recent photos feature gives a good idea about how that site changed during the last century.

The system has a link to the missions database which is currently under development by the "College de France". Using this feature enables the user to read all the excavation mission reports on work at this site.

The system is also linked to the database of the Egyptian Museum in Cairo, that enables the user to browse through the collection of artifacts that are currently in the Egyptian museum and was originally found at that site. Fig. 4 shows how the objects information is displayed.

The user can also browse through other collections of artifacts that were found at the site and are currently displayed in other museums outside Egypt. This data base will be supplied by the CHAPILLION project that has been developed by Prof. Vander Plas in University of Utrecht - Holland.

Another GIS project is currently under development in the Supreme Council of Antiquities with the help of the Finnish Government which focuses on the documentation of the boundaries of each archaeological site, and how it intersects with the surrounding urban areas, agricultural areas and so on. A direct link between our project and the boundary map project will be established at a later stage to enable the user to see the details of the site boundary and intervening parameters.

Finally, if the currently selected site contains more than one monument, the "Site Details" option will be enabled to give the user the facility to move to the second level (the site level) of data to see the details of the monuments within the site. This will be covered in the next section.

The Search methods

The user can search for any site(s) using two different methods. Either to search by site data for sites satisfying certain criteria or to select site(s) directly from the map.

The data search:

As shown in figure 1, the user has the following search options to choose from:

- Search by name
- Search by period
- Search by type
- Combined search
- Search by governorate

Search by site name:

Once the user selects this search option he will then have the choice either to search by the site's current name, ancient Egyptian name, Coptic name, or Greek name. Selecting any of these options will display the corresponding list of sites names (current, ancient Egyptian, Coptic, or Greek) (see fig. 5). Once the user selects any name the corresponding site will be selected and highlighted on the map.

Search by Period:

Through this search option the user can perform three types of search. Search for sites with a specified dominant period, search for sites with a specified dynasty or search for sites with a specified non dominant period. When the user selects the first search option he will be asked to select a pharaonic time period from a list of all periods (see fig. 6). Once he selects a period, a list of all dynasties within the selected period is displayed. If the user clicks the "Search" button at this point the system will return all the sites having the selected period as a dominant period. To search for sites within a certain dynasty, he will have to select a dynasty from the list and then click the "Search" button. And finally, to search for sites with certain non dominant periods, the user will have to click the "Other Periods" button to redisplay a list of all periods to select from and then click the "Search" button.

Search by site type:

As mentioned before, the remains type data is divided into two levels: the main type and the secondary type. Using this search option the user will be able to search for sites that have a specified main type or specified secondary type. Clicking the "search by type" button will open a screen with a list of the main types (see fig 7). When the user selects a value from this list another list with all the secondary type values related to his selection will appear. To search sites with their main type just click the "search" with no secondary type selected. To search by secondary type the user will select a value from the secondary type list then click the "search" button.

Combined search:

The combined search option enables the user to perform more advanced search than those mentioned above. Using this search he will be able to form his own query combining the period and the main type fields. When the user clicks the "Combined Search" button a screen containing a query builder will appear from which he will build his query in the following way (Fig 8). First, the user will select one of the two fields "period" or "type" by clicking the corresponding button. Clicking any of the buttons will type the selected fieldname in the query box, and display a list of all possible values of the selected field. The user then should select the value he wants to search for from the list. Once a value is selected, an equal sign followed by the selected

value will be typed in the query box to show the user what his query looks like. To add another condition, he has to determine first how the new condition relates to the first one. That is to be done by either clicking the "AND" button to select an AND relation or the "OR" button to select an OR relation. Selecting the relation button will also type "and" or "or" in the query box. After selecting the relation he will form the new condition in the same way he did the first one. In the same way the user can add as many conditions as he needs to build advanced queries. For example, after performing the above steps, the query box may contain a string like "([Period] = 'Old Kingdom') And ([Type] = 'Necropolis')". To prevent any confusions in sequence while using the query builder we designed it to disable any group of buttons when they should not be used.

Search by governorate:

The use of this search option enables the user to search for all sites that are located in a certain governorate. Clicking the "Search by governorate" button will display a list of all the Egyptian governorates. To search for a certain governorate, the user should select one from the list and then click the "search" button.

Search from the map:

The second search method is to search from map. Using this search method the user is able to visually select a site or a group of sites directly from the map. Clicking the "Search from map" button will open a screen with an empty list and the user will be able to either click any site on the map or draw a rectangle around a group of sites to select them. Once the user selects any sites a list of all the selected site names will be displayed in the empty list, and again the user will have the ability to make further refinement to his search by selecting only the sites of his interest from that list to display their information. This method is very useful if one is looking for a site and he knows its location but he can not remember exactly the site name. All he has to do is to select all the sites in this area and then look in their names to remember the name of the site he is looking for.

The search results:

The search results for all the previously mentioned search options are displayed in the same way. When the system displays a search result, it hides all the sites on the map except those that satisfy the search criteria and they will be displayed in a different color. At the same time, a list of all these site names is displayed for the user to select any of them to display its information. Once any site is selected it will be marked on the map to show its location. Visualizing the geographical information, especially in the search results, has a great value for researchers as it can open new fields for research. Studying the different geographical spectrums generated by different queries may result in new discoveries in Egyptian history. Fig 9 shows how the system displays a search result.

The Second Level: The Site Level

Many of the Egyptian archaeological sites, such as Luxor temple, contain only one monument. But at the same time there are some sites that contain thousands of monuments like the Giza Plateau or the Saqqara area. The main aim of the site level is to

document the information on the monuments at such sites. And again one of the most important items of information is the location of each monument within the site. At this level a satellite image of the site is displayed, with each monument marked by a polygon. At this level the main entity is a single monument. For example, the Giza Plateau is represented with a single point at the first level although it contains more than 8000 monuments including the pyramids and the sphinx. When the Giza Plateau is selected, the user can click on the "Site Details" button to move to its second level of information.

Similar to level 1, the user may select a certain monument directly from the image or search for monuments in the site by their owner name, by dynasty, by monument type, or a combination of search criteria.

Once a monument has been selected, its location will be highlighted on the map and its basic information will be displayed. The monument's basic information contains the following attributes:

Owner name:

This field contains the name of the monument's owner if it is known.

The monument dating:

This indicates the period of time in which this monument was built. The structure of this attribute is similar to the dominant dating of the site at the first level, which means it also contains information about the Historic Period, Pharaonic Dynasty, and the King's name in whose reign the monument was built.

Structure:

This attribute contains information about the structure of the monument itself, for example stone built, rock cut, etc.

Type:

This indicates the type of the monument, for example Pyramid, Tomb, Mastaba, etc.

Bibliography:

This states all the references that have published any information about the monument.

PM and LÄ:

Exactly the same as at first level.

Description:

Contains a brief description of the monument.

In addition to basic information on the monument the user has the option to see more detailed information about the monument by clicking the "Monument Details" link. This will lead him to the third level of data that will be described in the next section.

The Third Level: The Monument Level

The main aim of the monument level is to document every fine detail of the monument, including its geometry, structure, the

pharaonic scenes on the walls and even the translation of each hieroglyphic text that is written on these scenes. The best representation for this kind of documentation is to create a virtual tour inside the monument. This gives the user a complete feeling of what the monument really looks like, the architecture of the monument, and how the scenes are distributed on its walls, etc. Using 3D modeling and multimedia technologies, a 3D model of the monument is built and easy-to-use navigation tools are added to it. Moreover an exact documentation of the monument walls is implemented by employing a photogrammetry system to produce high quality to scale photos of the monument walls.

Once the user clicks the "Monument Details" button he will be transferred to the virtual tour screen of the currently selected monument as in (Fig 12). The screen contains a 3D model of the monument in which the user will be able to freely walk through the monument using the arrow keys. Beside the 3D model, a plan view of the monument appears with an arrow illustrating the position and the orientation of the user at any time. In addition, the user can change his walking speed using the speed control or enlarge the 3D view to fill the screen for a better view.

At any time during the tour the user can click on any of the monument walls to zoom into the scenes engraved on it. A line drawing of the scene with multiple zoom levels will be displayed. By rolling the mouse pointer over any piece of hieroglyphic text, its English translation will be displayed. The facility of a magnifier to magnify the wall scenes is also provided. (Fig. 13)

The system's additional outputs

The system also delivers additional outputs such as printed geographical atlases of the archaeological sites of Egypt. Atlases are produced for each governorate. Each atlas includes a set of maps of the archaeological sites grouped either by administrative areas, their management department or their legal status. Another output that we plan to work on is a set of multimedia CD ROMs containing virtual visits to subsets of the monuments of the system.

Current status and future plan

The project started at the beginning of year 2000, during which period we have completed the first level of data and we are now in the data revision phase. At the second level we have started with the Giza Plateau which contains more than 8000 monuments. We have already finished around 60% of the work at the site. As for the third level, which is the most time and effort consuming level, we have completed six of the Giza mastabas to date.

We are planning to complete the second level for all Egypt, within a time frame of five years. The third level is a very long task indeed. It develops at the rate of two virtual tours per month. We also plan to produce the first CD ROM including a set of the Giza Plateau mastabas by the year 2002.

Implementation Highlights

As we mentioned before the project is implemented using different technologies which are:

- 1) GIS
- 2) Data Base
- 3) Multimedia
- 4) 3D Modeling

We used Arc View V3.2 for building the GIS part of the system. Arc View was chosen because it is a very commonly used software hence the availability of developers and good technical support. The programming language of Arc View, which is called Avenue, gave us the ability to customize the user interface of the system to produce an easy-to-use interface for non-geographic experts. Finally, Arc View has the ability to connect to any type of databases through Open Data Base Connection.

The database used is Microsoft Access. In addition to its wide popularity, Microsoft Access is a very portable and compact data base. A single file can hold all of our tables, pre-built queries, reports and also all the data entry interfaces. This file can easily be transferred from one computer to another with all of the needed data. This feature helps a lot in maintaining the data integrity especially in our case as the updating process of the data is a never-ending process. In addition to all of the above, Microsoft Access is very suitable for smaller databases which is the case in our database.

In multimedia authoring, we used Macromedia Director Shockwave Studio V8.5. During the last few years Director had proved to be one of the best multimedia authoring tools available in the market. By using Director, the developer can easily integrate all types of media files in one executable file with a very high synchronization precision. In addition to the powerful programming language the Director provides, it also gives the multimedia developer a very powerful set of commands to completely control all types of media files. Moreover the latest version of Director V8.5 has come up with a new amazing feature which is the 3D support. This feature enables the developer to seamlessly integrate a 3D world inside Director. Director 8.5 provides the developer with a large set of commands to control each element in a 3D environment at run time also receiving messages and events from any object in the 3D.

Another advantage is that the Director project can be compiled to a single ready-to-run executable file without any need to setup or register any extra files to the system. This feature made the process of calling this file from within Arc View very simple.

In the 3D modeling we used 3D Studio Max 4 for many reasons. The first is that 3D studio is one of the oldest and most famous 3D packages available. The second is the ease of its use compared to other 3D software. In addition the availability of modelers and animators experienced in it. Moreover 3DS Max is the best for structural non-organic modeling. And finally the compatibility of 3DS Max with the new version of Macromedia

Director as we can easily import any Max scene in the director project.

End Notes

Without the help and the vision of Dr. Gaballah Ali Gaballah, the secretary general of the Supreme Council of Antiquities, this project could never have come to light the way it did.

We would like to acknowledge the effort made by Eng. Mohamed Farouk for the management of the project in addition to the design and implementation of the third level ideas, Eng. Mona Tawfik for the development of all the GIS parts of the system, Mr. Maher Amer who is responsible for the geographical data of the sites, Eng. Omar El Gendi for the database administration, Eng. Motaz Mahmoud for the development of the third level, Eng. Tarek El Morry for the photogrammetry work. In addition to the technical team we would also like to acknowledge the Egyptologists team for gathering, revising and refining the historical data, the team is headed by Dr. Fayza Haykal and consists of: Dr. Basma Koura, Dr. Mamdouh El Damaty, Dr. Randa Baleegh, Dr. Mohamed Hassoun, Dr. Hassan Seleem, Dr. Mostafa Attallah, Mr. Loay Saeed, and Dr. Ghihan Zaki. A very special acknowledgment goes to inspectors in every inspectorate of the Supreme Council of Antiquities who helped in the overall inventory of different sites all over the country.

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- <http://www.descreet.com/>

Figures

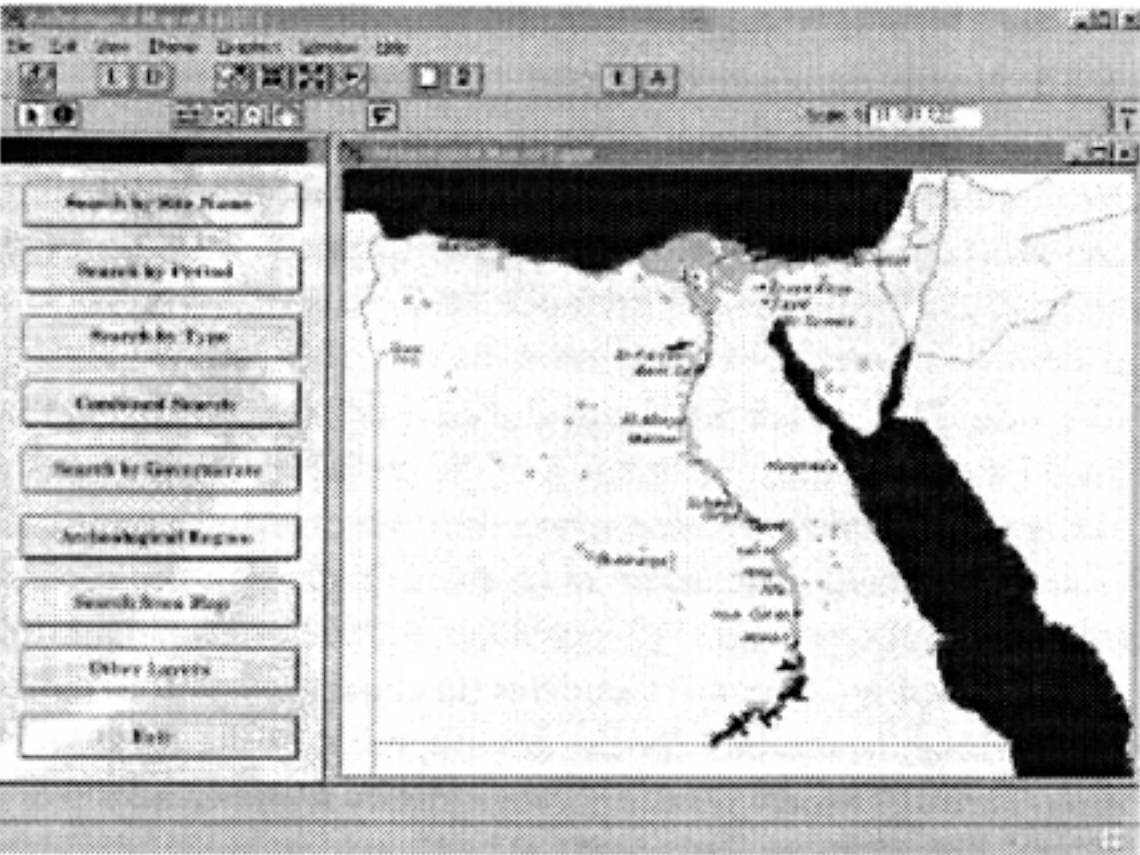


Figure 1. The main screen of the Archaeological Map of Egypt

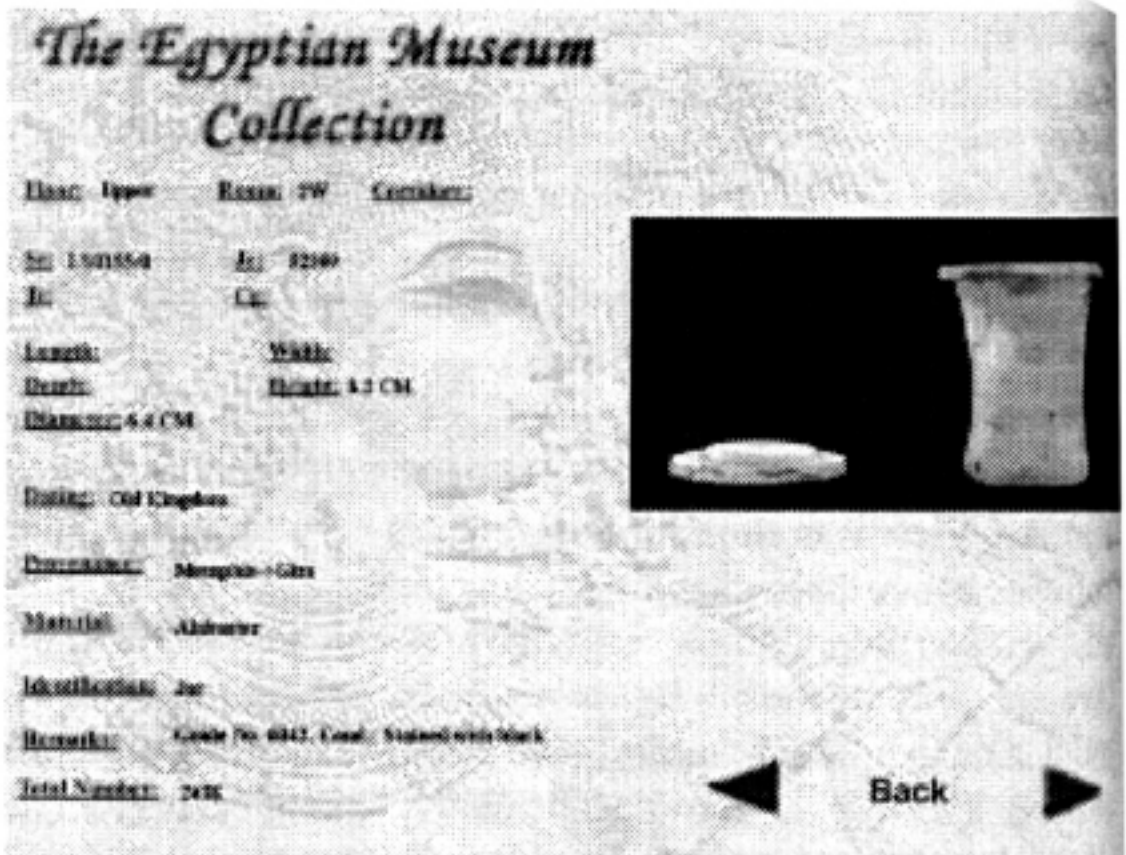


Figure 4. Objects currently in the Egyptian Museum



Figure 2. Information in Level 1 of a selected site

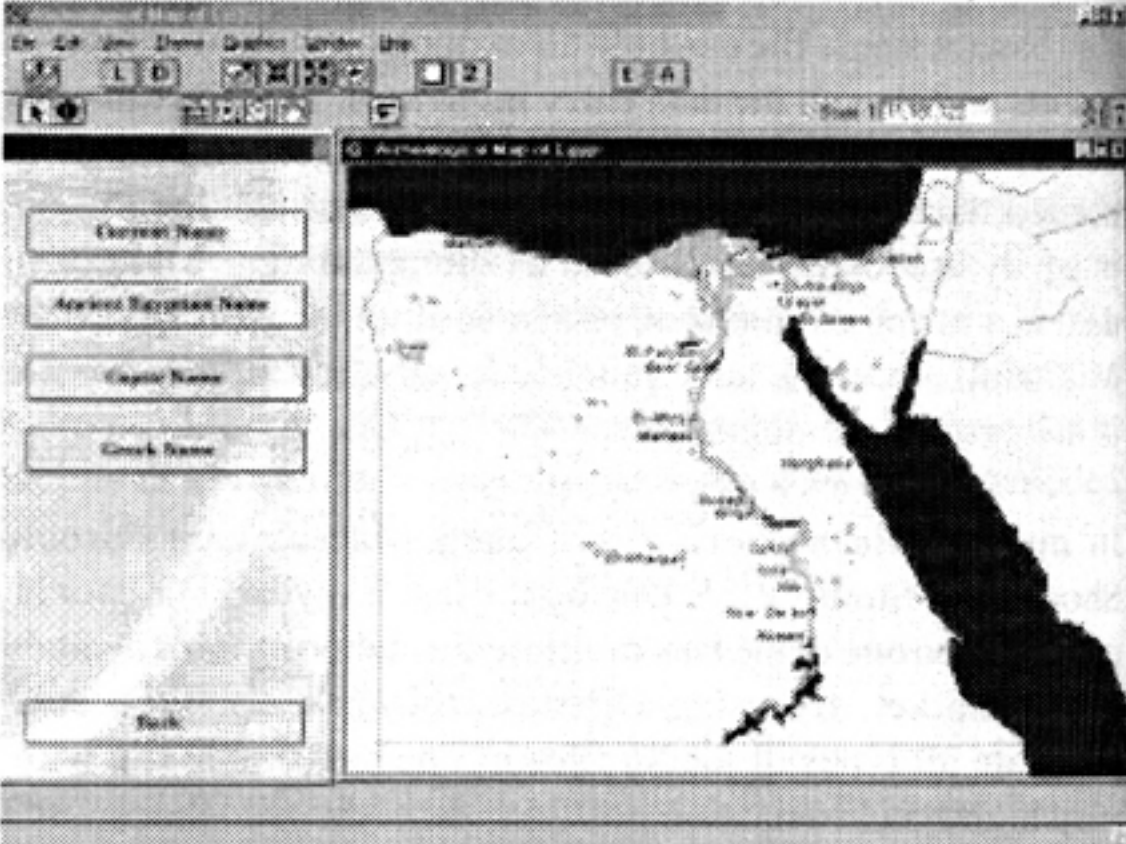


Figure 5. Search by site name screen



Figure 3. Basic information of the site



Figure 6. Search by period screen



Figure 7. The search by type screen

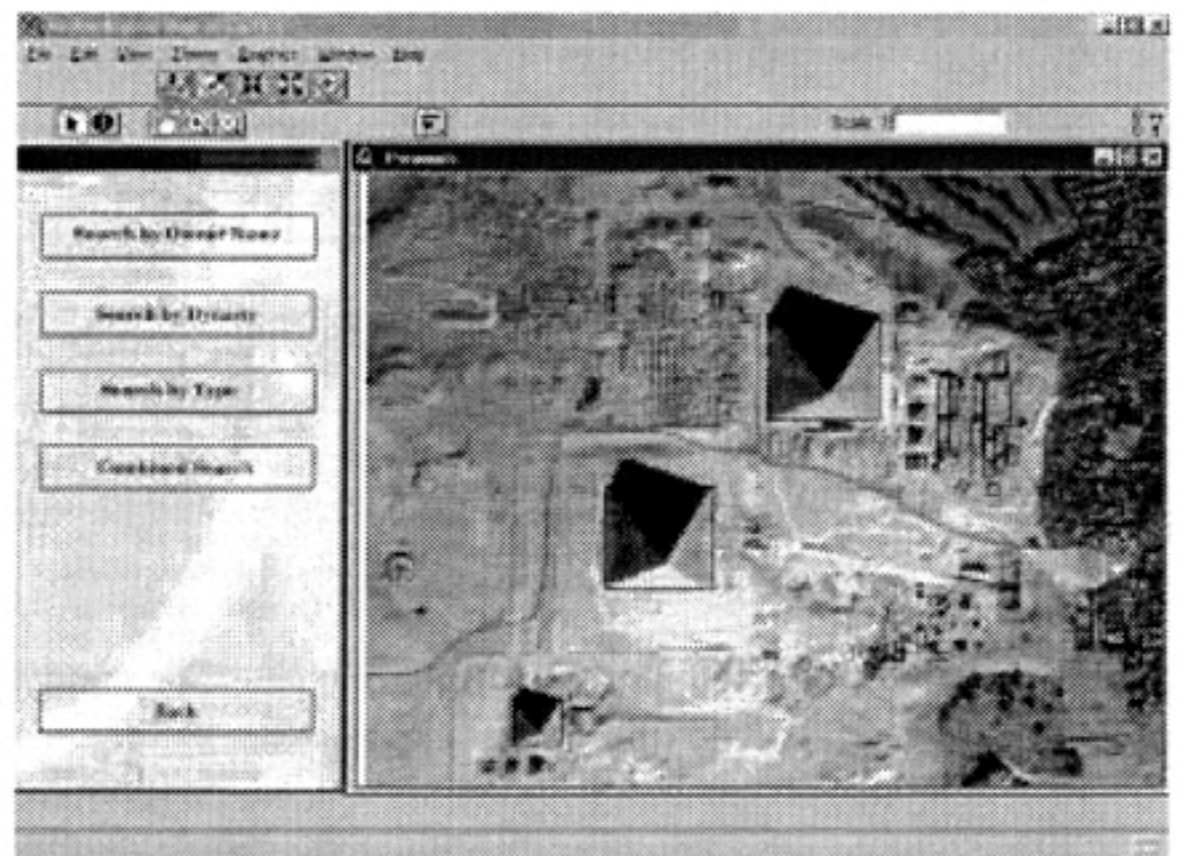


Figure 10. Second level of the Giza Plateau site

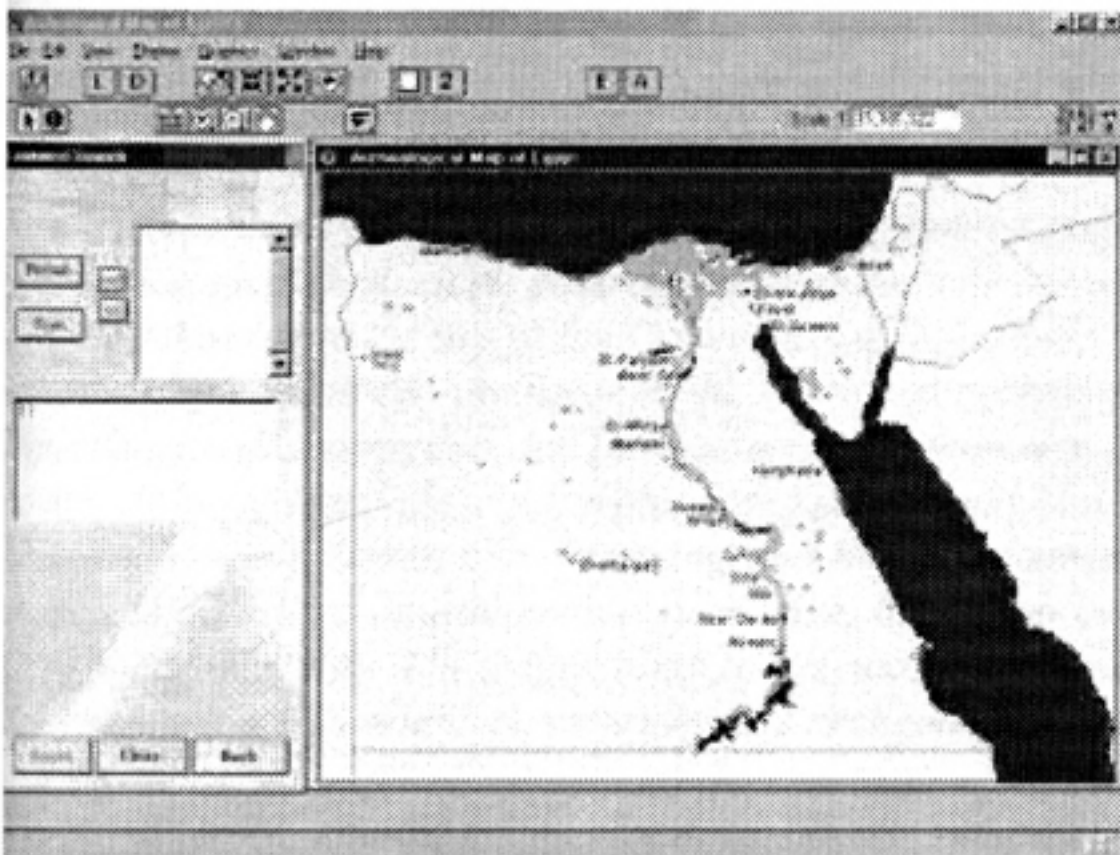


Figure 8. The query builder screen

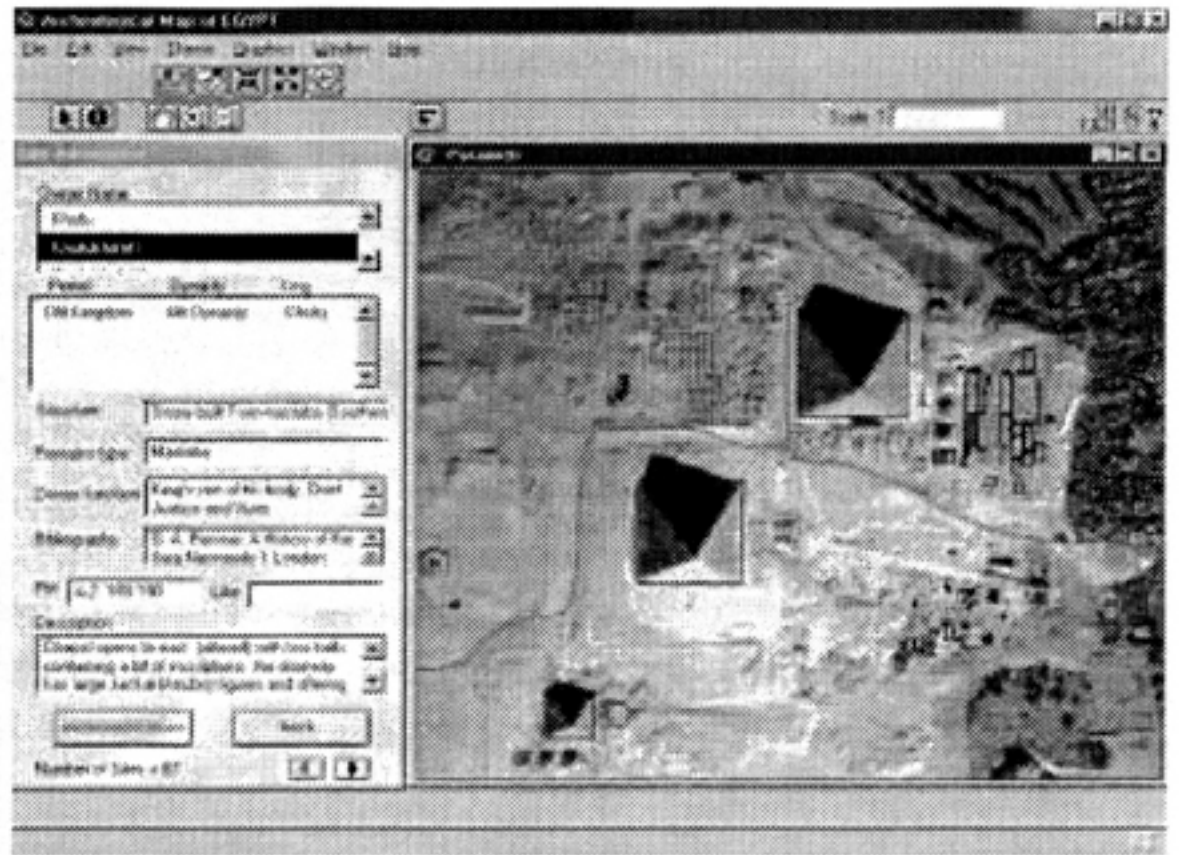


Figure 11. Monument basic information



Figure 9. Fig a search result screen

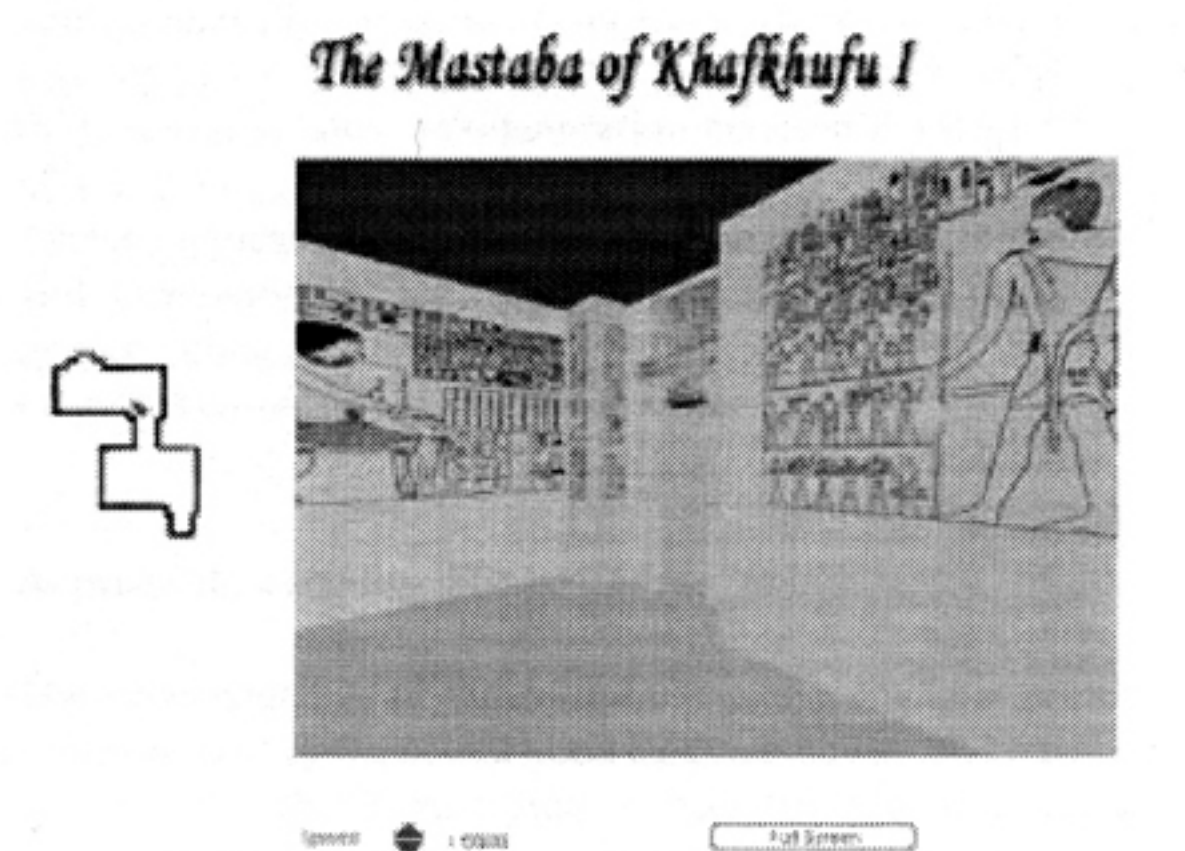


Figure 12. The virtual tour screen

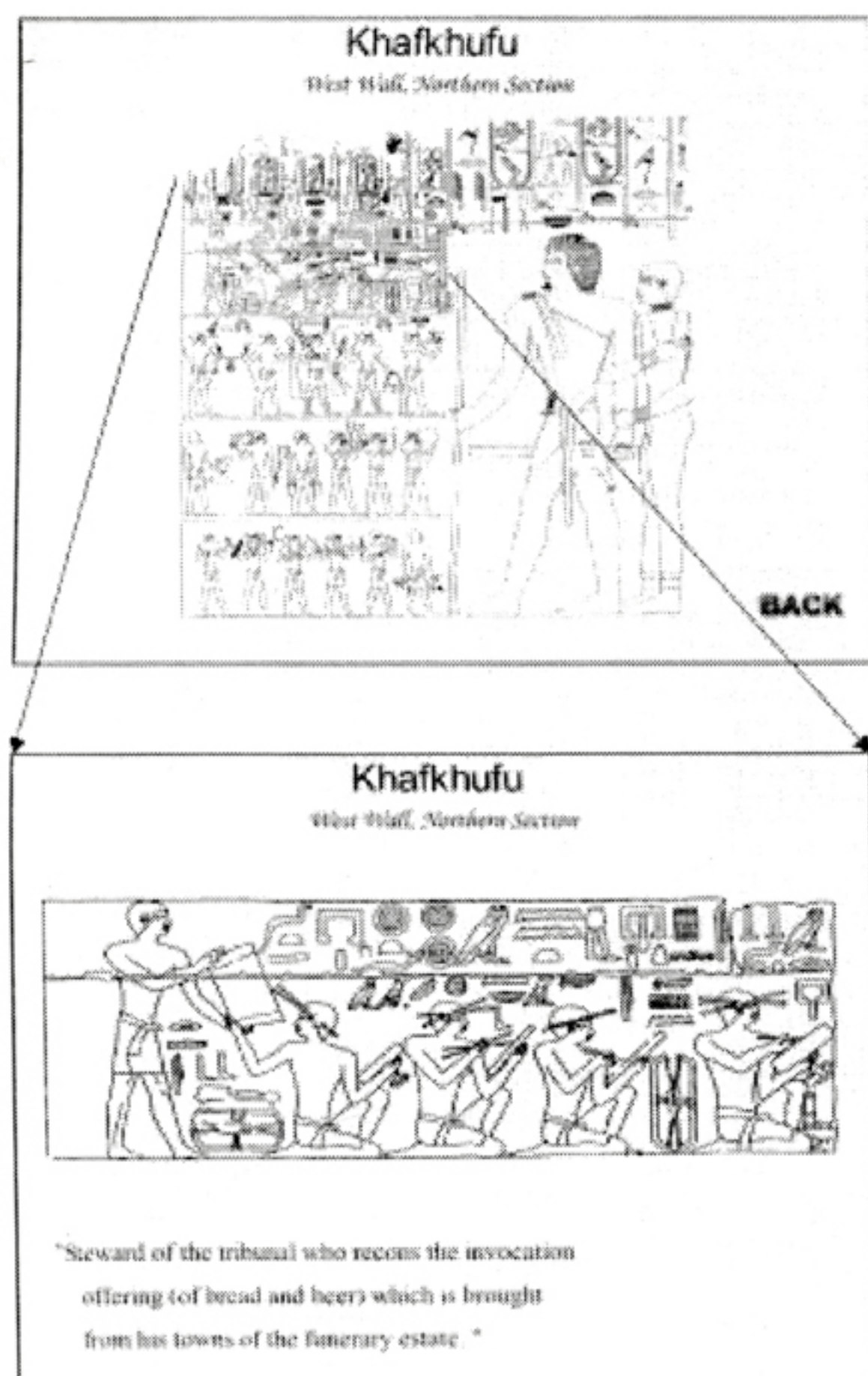


Figure 13. The scene details

Geographic Information Systems and Archaeology: the case of ancient Nora (Pula-Cagliari)

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Abstract: The Punic-Roman ancient city of Nora is located on the Sardinian south-western coast, near Cagliari, the most important sardinian city, on the south coast. Latest excavations and territorial surveys of Nora (1990-2000) have proved the continuous settlement between Phoenician-Punic-Roman and Late Roman periods (VII BC-VIII AD). The need of urgent updating of archaeological, historical, environmental data, with monitoring on ancient urban decay (ancient mosaic floorings and other structures) has led to the use of the Geographical Information System in order to solve archaeological problems and to improve research on Nora. In this prospective the study and reflections on ancient city, based on interdisciplinary research between the Dipartimento di Ingegneria del Territorio and Monuments and Fine Arts Office, have begun. The research deals with several points: Cultural Heritage, Archaeological Surveys and Field research, Intra Site Applications, Scientific studies. We evaluate problems between Urban City Planning and historical-environmental resources, respectively. The identity of present territory cannot be described as inalterable substance, but it can be considered as the continuous historical stratified result of local Community mentality. The paper aims to discuss some advancements in the Nora city planning research and to propose the description of a GIS oriented system for the archaeological assets and management of the cultural heritage.

Key words: Nora, ancient urban planning, ancient roman Sardinia, archaeological Information Systems, cultural heritage.

Introduction

The Nora peninsula stretches out into the Mediterranean Sea in an unusual shape, which, nevertheless, allows to include this site among the geomorphologically characteristic sites of a number of coastal areas in Sardinia. These include the promontories of Tharros, the lagoons of Carales and Bithia, the settlements of Bosa Vetus, Olbia, and the east coast as far as Villasimius. All these settlements are characterized by the presence of coastal lagoons, promontories, and coasts with precise harbor characteristics.

These geomorphologic characteristics partially contributed to create the privileged strategic conditions that have led to the establishment and development of the city of Nora. Research on the ancient site in the form of *excavation archaeology* started in the early 1950's. This damaged the city and caused the loss of most of the stratigraphies referable to the shallower deposits, which were irremediably compromised by the tendency to privilege the search of objects and remarkable things to preserve. In the 1990s stratigraphic excavations were at last started in Nora by a number of researchers from the Universities of Genoa, Padua, Pisa, Venice and Viterbo and from the Archaeological Superintendence for the Provinces of Cagliari and Oristano. The remaining parts of the stratigraphies destroyed in the 1950's, i.e. of the Pesce period, were excavated

stratigraphically, trying to reconstruct wherever possible the missing pieces of the history of the city of Nora. Parallel with these investigations, a collaboration between the Department of Land Engineering of the University of Cagliari and the Archaeological Superintendence for the Provinces of Cagliari and Oristano was started with the aim of studying and implementing an Information System for Nora. The Scientific Project is co-ordinated by Prof. G. Deplano.

A possible reading of the forma urbis

The reconstruction of the forma urbis of Nora is at present compromised by the actual knowledge of the city as known so far, and especially because it has not been possible to reconstruct its extension completely, though excavations have proceeded quite rapidly in the past years (MELONI 1990). Therefore the reconstructive hypothesis that will be attempted here will have to be revised when the inevitable following updates will be available as a result of further investigations. Nevertheless, considering what has emerged so far, and considering the different chronologies proposed by various scholars for the best known buildings, careful reading of the residual urban texture, shows few interesting elements that could be discussed today and in the future.

While it is not our intention to enter the debated problem of the phases of the foundation of the city of Nora (BONETTO-NOVELLO 2000), it can safely be stated that its urban phase started around the VII-VI century BC, at a crucial time in the history of this part of the Mediterranean Sea, when the balance of the forces at stake, i.e. the autochthonous population and the Phoenicians, was in favour of the latter. The original role of the city is not totally clear. It certainly must have been related both to the exploitation of the land's potentialities, whose economy depended on its rich hinterland, and to overseas relations with other Mediterranean poles of interest, such as Africa, Spain, the Balearic Islands, France, and Italy. Its relationship with Cagliari, for example, which must have been an important settlement already in the VII century BC, if not earlier, as shown by studies on the via Brenta area, is not clear (AA.VV. 1992). However, the same conformation of the small peninsula of Pula conditioned the roads which characterize its layout and which became more monumental from the Empire onwards, and therefore more clearly defined. No stratigraphic surveys have been made on road works in Nora. Nevertheless, a few data can be obtained from the supporting relationship among structures such as the theatre and the baths at sea, and road portions, considering that roads are supported and therefore are posterior to the two above structures and can be dated within the III century AD.

Even the country roads along the coast namely, the Cagliari road to the east and the *Bithia* road to the west, conditioned the city layout, since they joined the city roads at certain points that can be hypothesised with some certainty (BONETTO, forthcoming) and few observations, which should be integrated with new data from road findings, have been made. In fact two stretches of paved road in an east-west direction, parallel to the access road to the archaeological site, have been found in the north-eastern part of the city. The stretches are built with andesite slabs with a 20 cm kerb, and are 3.80 m wide and 5.70 m long. The remains of a large building tangent to the road with squared blocks of yellowish sandstone *in situ*, were also found in the same area. First of all this suggests an important fact: the city extended towards north-west covering the available space of the isthmus between the small lagoon and the sea. To what extent is difficult to tell. One thing is certain: the Sant'Efisio necropolis delimited the *pars urbana* near the sea towards north-east. On the other hand, it cannot be ruled out that the settlement used to occupy without interruption the spaces available in the hinterland and along the coastline. At a certain point this road must have joined the extraurban road system. Considering the presence of important buildings even towards north-west, i.e. at the furthest limit of the military zone, it must have joined the extraurban road system at some other place further on. It has been seen that the foundation of the city should probably be placed in the VII-VI century BC. Of this period we can only hypothesize an early organisation of spaces and roads, of which we know next to nothing, except for the banal consideration that it must have been shaped to fit the geomorphology of the site. It is obvious that, considering the strongly conditioning nature of the morphological characteristics of the small peninsula of Nora, both the Phoenicians and the Romans must have become adapted to this peculiar situation, for which an organic settlement was only during the empire, at least from the data in our possession. It should be remembered that the

terminology *cardus* and *decumanus*, which is often used to define the main roads in a city refers to a situation that is typical of a centuriation system, and cannot be used with another meaning (BONETTO, forthcoming).

The phases of the city

Which phases can be clearly characterised in the construction of a city layout? What is the distribution of spaces and the destination of functions? Regarding the pre-Roman phases, it can safely be stated, as already said, that the city developed in the VII-VI century BC, near the upland plain later occupied by the forum. This was an area assigned to the mixed destination of dwellings and public utility services. In the late republican age, this forum area underwent extensive town-planning restructuring (NOVELLO 2000)

In the first half of the I century BC, the area was reprogrammed to receive the forum square with its imposing paving. From a town-planning point of view, the forum is eccentric with the city core, an aspect described in Vitruvius treatise when dealing with the difference between forums in harbor cities and forums in internal cities (SOMMELLA 1988).

The location of public area par excellence is maintained in the town-planning history of the city.

As regards equipped areas, that is baths, fountains, and various works, the only clarified element so far is the link between the so-called *insula A* and the west harbor. The *insula A* is characterized by a large two-storey building complex that includes *tabernae*, actually *ergastula*, and dwelling areas on the top floor (GUALANDI-RIZZITELLI 2000). The excavation of part of the hill on which the *insula A* was later built in the middle of the III century AD (RIZZITELLI 2000) was a very significant event in the town-planning. This indicates a precise decision to refunctionalise an area related to port activity. Besides this important planned operation related to *insula A*, several other smaller works for the community life were carried out. These refer to public service areas, that were continuously on the increase during the Empire and can also be defined as the "district" level based on privileged mileage and on the inevitable attraction of crossroads: this is the case of the Small Baths that were linked to the AB block, of the Baths at Sea that were linked to the harbour, of the Central Baths that were linked to east and south oriental districts of the city, and of the Eastern Baths that were linked to the eastern districts to the city and perhaps to the supposed eastern anchorage (VERDUCHI 1995). The Small Baths building, which was originally destined to serve a block along the largest western artery of the city, was transformed perhaps in the IV century AD in successive phases from a private *balneum* to a public establishment, with the addition of new parts to evolve completely a new function of the complex (COLAVITTI, forthcoming)

The Baths at Sea are located beside an important crossroad between an east-west axis and a north-south axis. At this point the east-west road proceeded in this direction, but it can no longer be determined today because the area has been buried by bradyseism, which characterized this stretch of coast. The

works were carried out in the imperial Age but before the construction of the *insula A*, therefore in the II century AD (TRONCHETTI 1984)

Sacred areas represent a separate problem in the urban context of the city. Little is known about them, because, except for the area located on the Coltellazzo promontory, they have never been investigated with the stratigraphic method. The most important buildings are located on the top of the two promontories that characterize the Nora area: i.e. the Coltellazzo sanctuary and the sacred area of Aesculapius-Eshmun. A threephase chronology, can only be proposed for the Coltellazzo area: an establishment phase in the VI century BC, a Carthaginian phase in the IV-III century BC, and a function restructuring or maintenance phase in the Roman republican period (OGGIANO, forthcoming). Other important sacred buildings must have gravitated around the forum, as the one hypothesized in the north-eastern part, where archaeological excavations are currently in progress.

The history of the settlement of Nora partly changes in the post-classical period. Few nuclei of the settlement certainly survive from the imperial Age in different forms, such as the western nucleus where a certain continuity of life planning has been observed with the continuation of building activity, the reutilisation of materials and techniques, the abandonment of structures, and the filling up with earth of a few areas (COLAVITTI.-TRONCHETTI 2000; BEJOR 2000).

Some of the main roads, such as G-H, are maintained efficiently, suggesting that the area or part of it was to receive some kind of new connotation in the general equilibrium of the site, which still escapes from our attention. Next to maintenance and the transformation of the city layout, was the phenomenon of Christianisation of the urban space, which was also felt in Nora, where it established itself and developed rapidly. The material signs of this period seem to be relegated externally with the creation of a pole around the church of Sant'Efisio, which partly re-utilizes a sepulchral pre-Christian area.

The construction of an information system for the city

First of all, why should we build an Information System for Nora? The simplest answer to this question is: to be able to manage the archaeological information on the city and its territory, by relating and comparing it to non-archaeological themes, such as the geomorphology of the site, the geopedology, the economic data of the Pula area and other themes, with the aim of revealing and enhancing an enormous heritage so intimately related to the problems of the Mediterranean space. Furthermore, with a Geographic Information System, different types of users can be brought together, such as the University, the Archaeological Superintendence, and the Local Authorities. Each of them could use can use the information according to his competence, in order to communicate such pressing themes as the infrastructures to be built in real times in touristic-cultural areas. Once this premise has been accepted, the priorities to build the entire system need to be established. The growing to update the historical, archaeological, and environmental data must proceed hand in hand with a continuous monitoring of the

degradation problems on the site and of the efficiency of the established methods of protection and restoration. Therefore the decision to use the information tool, which is opened in new fields of application, comes from the prospect of solving many problems related to the complexity of the archaeological site, in order to establish a correct relationship between the processes of land use planning and its historical-environmental resources. To build an archive of the ancient city would be in itself an action of great importance in planning any future event, even in the field of activity of archaeological excavation. It has been stated that since Geographic Information Systems have not been created for archaeology, they are structured on blocks of data that are strictly related to geographic and environmental variables, which the archaeologist is incapable of adapting to his research (LOCK-STANCIC 1995).

This could be true if we don't consider that a GIS is the expression in space of an archive of data.

Therefore the **Information System** for Nora, is structured on an **Archive** of data, which shows all the necessary and useful information, aimed first of all to describe first of all the archaeological level.

This information is easily interfaced with other information levels that we consider functional in explaining the greatest possible number of elements. To this purpose, we have studied a few descriptive records of the archaeological level that make up the first phase of implementation of the entire system. The architecture of the system includes a GIS platform, a management system of relational databases, and a hypertext. Thanks to the hypertext the information can be structured without having to carry out a close examination of the vast field of spatial analysis that is the heritage of more expert figures who would still have to converse with other users. The records (1-2-3) show the main categories of spatial data and attributes that make up the system, and which can be used to carry out interrogations and analyses.

Record 1 (fig. 1)

Localisation (town-underwater land)

Conditions: Visible-non visible

Protection: Restricted-restored-not restored-not specified

Record 2 (fig.2)

Modality of recovery (from excavation -other)

Object characteristics: Immovable-free area-additional information

Record 3 (fig. 3):

Architectural complex (Fragmentary Planimetric Unit)

Functional interpretation

Chronology

Existing documentation

Literature references

The principal aim of GIS oriented system for archaeological assets is to draw up the documentary evidence from the beginning of the strathigraphic research in Nora. This fact represents a further steps to site management and perhaps to think ways for further research within urban ancient planning

and contemporary environmental Nora-Pula planning. Also monitoring the dilapidated state of ancient buildings and the studying of projects and schemes where we can research on management policy can be included in the same project. Finally the whole project will provide for Nora and Pula complete thematic maps, for example on the ancient building technologies and on the preservation of buildings and environment.

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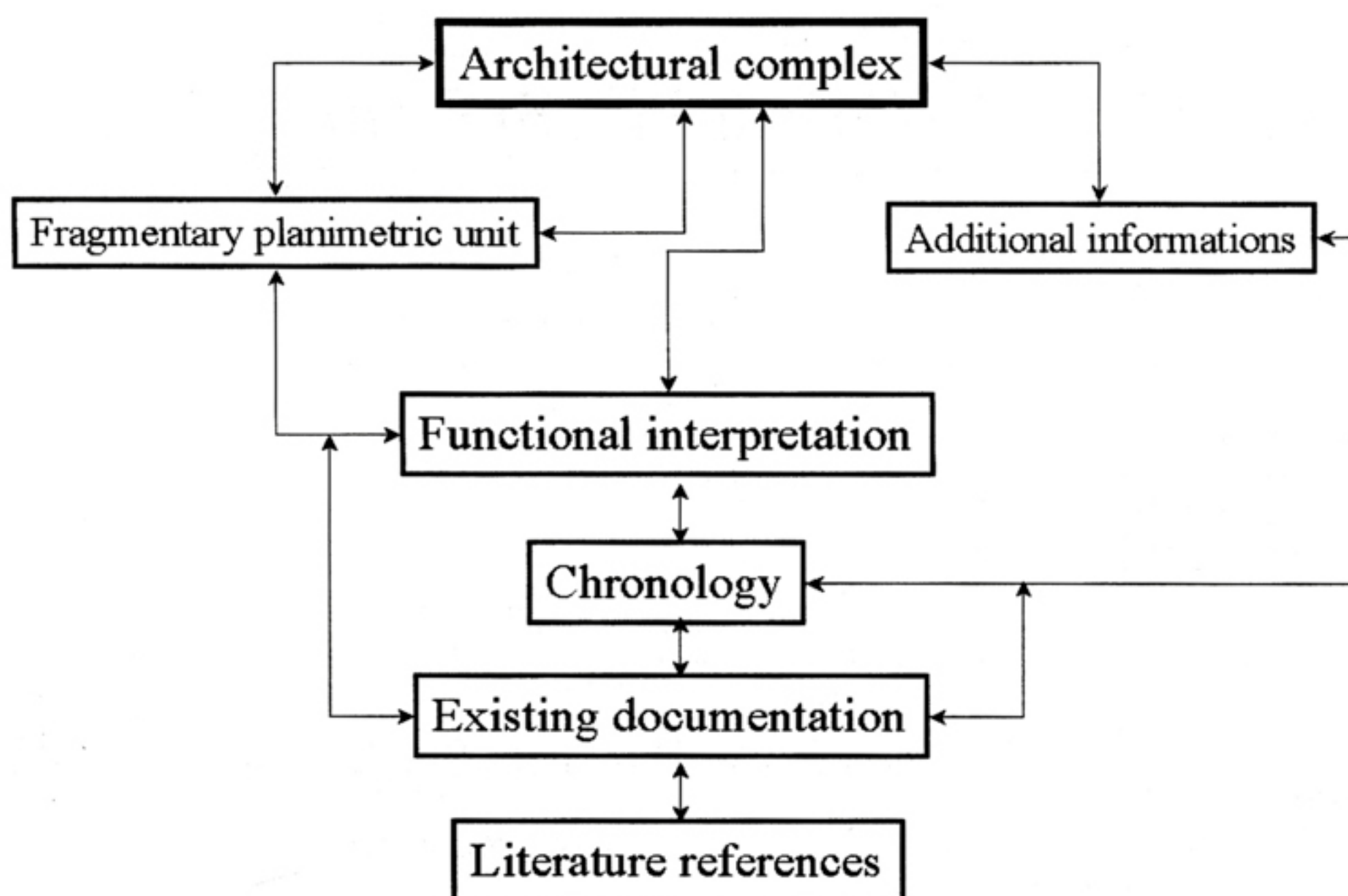
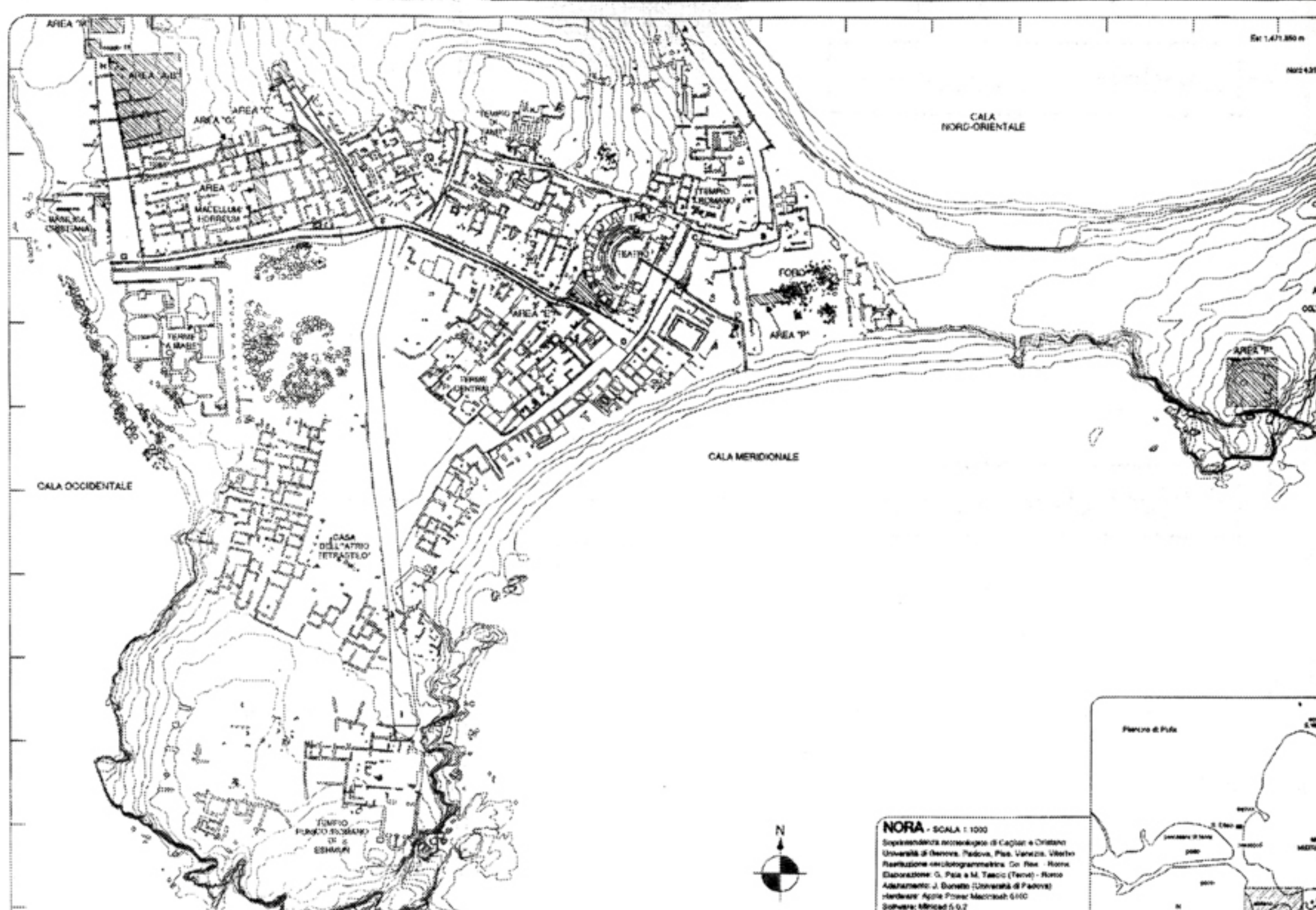


Figure 3.



Map 1.